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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/986,267	11/08/2001	Minh Van Ngo	50432-204	5014

7590 04/17/2003

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EXAMINER
BROPHY, JAMIE LYNN

ART UNIT	PAPER NUMBER
2822	

DATE MAILED: 04/17/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/986,267	Applicant(s) NGO ET AL.	
	Examiner J. L. Brophy	Art Unit 2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *31 January 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-16* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2 and 4-15* is/are rejected.

7)☒ Claim(s) *3 and 16* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☒ The proposed drawing correction filed on *31 January 2003* is: a)☒ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

This office action is in response to the amendment filed 1/31/03.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 2, 4, 5, 7, 8, 11 and 13-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al (6,261,963) in view of Ritzdorf et al (Patent Application Pub. No. US 2002/0000271).

Zhao et al teach a method comprising forming an opening 220 in a dielectric layer 130, wherein the opening 220 is a dual damascene opening containing a lower via hole section in communication with an upper trench section, and wherein the dielectric layer 130 may be FTEOS (col. 4, lines 51-52);

Depositing a barrier layer 325A comprising tantalum or tantalum nitride or the like (Fig. 3 and col. 5, lines 22-27);

Depositing a seed layer 525B on the barrier layer (Fig. 5);

Depositing Cu or a Cu alloy 640 by electroplating (col. 5, lines 65-67) to fill the opening 220 to form an upper line in communication with an underlying via 140;

Thermal annealing the deposited Cu or Cu alloy 640 in NH_3 (col. 6, lines 40-45); and

Conducting CMP such that an upper surface of the deposited Cu or Cu alloy 640 is substantially co-planar with an upper surface of the dielectric layer 130 (Fig. 7).

See Figs. 1-7 and accompanying text.

However, Zhao et al do not specifically teach a laser thermal anneal.

Ritzdorf et al teach a method that comprises applying a laser thermal anneal to a copper layer 440. See Figs. 2E, 2F and 15 and accompanying text.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method taught by Zhao et al by laser thermal annealing the copper layer because laser annealing is more precise than furnace annealing (see Ritzdorf et al, p. 7, paragraphs [0070] – [0071]).

Re claims 2 and 4, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to optimize and select an appropriate radiant fluence of the laser beam and a flow rate of the NH_3. The selection of parameters such as energy, power, concentration, temperature, time, depth, thickness, etc., would have been obvious and involve routine optimization which has been held to be within the level of ordinary skill in the art. "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may be impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from results of prior art...such ranges are termed 'critical ranges' and the applicant has the burden of proving such criticality...More particularly, where the general conditions of a claim are disclosed in the prior art, it is

not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 105 USPQ 233, 235 (CCPA 1955). See also MPEP 2144.05.

Claims 6 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al as applied to claims 1, 2, 4, 5, 7, 8, 11 and 13-15 above, and further in view of Cabral et al (EP 0751566).

Zhao et al in view of Ritzdorf et al teach a method that comprises annealing a Cu or Cu alloy layer in NH_3 with a laser anneal. In addition, Zhao et al teach a barrier layer lining the opening before deposition of the Cu or Cu alloy layer. Re claim 9, Zhao et al teach the step of conducting CMP such that an upper surface of the deposited Cu or Cu alloy 640 is substantially co-planar with an upper surface of the dielectric layer 130 (Fig. 7).

However, Zhao et al in view of Ritzdorf et al do not teach that the barrier layer is a composite comprising a TaN layer on the dielectric layer, a layer of alpha-Ta on the TaN layer.

Cabral et al teach that the barrier layer 23 lining the opening in the dielectric layer 12 comprises a TaN layer on the dielectric layer, a layer of alpha-Ta on the TaN layer (col. 4, lines 47-49).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al by forming the barrier layer of TaN/alpha-Ta in order to decrease the resistivity (see Cabral et al, col. 7, lines 11-23). See, for example, Fig. 1.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al as applied to claims 1, 2, 4, 5, 7, 8, 11 and 13-15 above, and further in view of Islam et al (6,174,810).

Zhao et al in view of Ritzdorf et al teach a method that comprises annealing a Cu or Cu alloy layer in NH_3 with a laser anneal.

However, Zhao et al in view of Ritzdorf et al do not teach the steps of treating the upper surface of the Cu or Cu alloy in a plasma containing NH_3 and depositing a SiN capping layer on the plasma treated surface by PECVD.

Islam et al teach the steps of treating the upper surface of the Cu or Cu alloy 38 in a plasma containing NH_3 and depositing a SiN capping layer 40 on the plasma treated surface by PECVD. See Fig. 2-3 and accompanying text.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al by treating the upper surface of the Cu or Cu alloy in a plasma containing NH_3 in order to remove copper oxide from the upper surface of the Cu or Cu alloy and improve the adhesion between the copper interconnect and the SiN capping layer (see Islam et al, col. 3, lines 37-60). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al by depositing a SiN capping layer on the copper interconnect surface by PECVD in order to prevent the copper from diffusing into adjacent layers (see Islam et al, col. 3, lines 24-29).

Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al and Cabral et al as applied to claims 6 and 9 above, and further in view of Islam et al.

Zhao et al in view of Ritzdorf et al and Cabral et al teach a method that comprises annealing a Cu or Cu alloy layer in NH_3 with a laser anneal, wherein the Cu or Cu alloy layer is surrounded by a TaN/alpha-Ta barrier layer.

However, Zhao et al in view of Ritzdorf et al and Cabral et al do not teach the steps of treating the upper surface of the Cu or Cu alloy in a plasma containing NH_3 and depositing a SiN capping layer on the plasma treated surface by PECVD.

Islam et al teach the steps of treating the upper surface of the Cu or Cu alloy 38 in a plasma containing NH_3 and depositing a SiN capping layer 40 on the plasma treated surface by PECVD. See Fig. 2-3 and accompanying text.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al and Cabral et al by treating the upper surface of the Cu or Cu alloy in a plasma containing NH_3 in order to remove copper oxide from the upper surface of the Cu or Cu alloy and improve the adhesion between the copper interconnect and the SiN capping layer (see Islam et al, col. 3, lines 37-60). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Zhao et al in view of Ritzdorf et al and Cabral et al by depositing a SiN

capping layer on the copper interconnect surface by PECVD in order to prevent the copper from diffusing into adjacent layers (see Islam et al, col. 3, lines 24-29).

Allowable Subject Matter

Claims 3 and 16 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is an examiner's statement of reasons for allowance: none of the references of record teach all of the process limitations as claimed. Specifically, none of the references teach a method that comprises laser thermal annealing to reflow the Cu or Cu, in combination with the other claim limitations.

Response to Arguments

Applicants argue (middle of p. 3 of arguments filed 1/31/03) that the examiner did not establish the requisite realistic motivation to modify the methodology of Zhao et al by employing laser thermal annealing while retaining the ammonia. However, the examiner submits that the Zhao et al reference is relied upon for the teaching of annealing in an atmosphere containing ammonia and that a proper motivation to modify the method taught by Zhao et al is provided in the rejection (see p. 3 above).

Ritzdorf et al teach a method that comprises annealing a copper layer at a low temperature. Ritzdorf et al teach that the temperature may be below about 250-300°C (see, for example, paragraphs [0016] and [0059]) to protect the dielectric layer, but is

preferably below 100°C (see, for example, paragraph [0011]). Such temperature ranges overlap with the annealing temperature ranges taught by Zhao et al (see Zhao et al, col. 6, lines 40-44). Ritzdorf et al do not disclose any gases that may be present in the atmosphere during annealing. Applicant argues (p. 4) that ammonia would not be used and different temperatures would be employed if the annealing technique disclosed by Ritzdorf et al were used in lieu of the annealing technique disclosed by Zhao et al. This argument is not found persuasive since it is unclear why ammonia would not be used and different temperatures would be employed. Since Ritzdorf et al do not disclose any gases that may be present in the atmosphere during annealing, Ritzdorf et al do not teach away from ammonia and applicant has not specifically pointed out why he believes that ammonia would not be used. In addition, since the temperatures disclosed by Ritzdorf et al and Zhao et al are overlapping ranges, it is not clear why different temperatures would be used. Ritzdorf et al teach that laser annealing (Fig. 15 and accompanying text) may be used as an alternative to other annealing methods (Figs. 11-14 and accompanying text).

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to J. L. Brophy whose telephone number is (703) 308-6182. The examiner can normally be reached on M-F (8:00-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (703) 308-4905. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

J.L.B.

jlb
April 10, 2003

AMIR ZARABIAN
SUPERVISORY PATENT EXAMINER
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